ELEMENTS OF THE NATIONAL AIRSPACE SYSTEM

2

2 ELEMENTS OF THE NATIONAL AIRSPACE SYSTEM

The National Airspace System is an interconnected system of airports, air traffic facilities and equipment, navigational aids, and airways. These elements of the NAS are operated and supported by airport employees, air traffic controllers, technicians, airspace specialists, and others.

Airports, air traffic facilities and equipment, and navigational aids are static physical components of the NAS. Over longer periods, airports may be expanded as new runways, taxiways, and terminal buildings are built; new air traffic facilities may be built and air traffic equipment and navigational aids modernized. In contrast, the condition of the airways changes continuously, as they are affected by changing weather, winds, and traffic. This chapter describes both the static and dynamic elements of the NAS.

2.1 Airports in the United States

Although there are more than 19,000 airports in the United States, over 5,000 of which are open to the public, the FAA considers only 3,367 to be significant to the capacity of the NAS. These airports are included in the National Plan of Integrated Airport Systems (NPIAS) and are eligible to receive Federal grants under the Airport Improvement Program (AIP). Within the NPIAS, the airports are divided into two major categories: commercial service airports and general aviation airports.

2.1.1 Commercial Service Airports

Commercial service (CS) airports are public airports receiving scheduled passenger service and having 2,500 or more enplaned passengers per year (an enplaned passenger is a passenger on a scheduled or unscheduled commercial flight). Figure 2-1 shows the classifications of the 546 commercial service airports as well as the percentages of enplaned passengers for each class. The 422 airports that have more than 10,000 annual enplanements are classified as primary airports. Those commercial service airports enplaning from 2,500 to 10,000 passengers annually are classified as “other” commercial service airports.

Within the primary airport classification, the term “hub” is used to identify very busy commercial service airports. This use of the term hub is different from that used in the airline industry, where a hub is an airport where passengers connect with other flights coming from the spokes of the system. The NPIAS term does not differentiate between airports with mostly connecting traffic and those with mostly origin-destination traffic. The primary airports are divided into large-hub, medium-hub, small-hub, and non-hub airports, based on the number of annual enplanements. Large-hub airports are those that account for at least one percent of total U.S. passenger enplanements. Medium hubs are airports that account for between 0.25 percent and one percent of total passenger enplanements and small hubs from 0.05 percent to 0.25 percent of total passenger enplanements. Commercial service airports that enplane less than 0.05 percent of total passenger enplanements but more than 10,000 annually are classified as non-hub primary airports.

Type of Airport	Number of Airports	Definition of Airport Type	Percentage of Enplanements
Large-Hub	31	At least 1% of passenger enplanements	69.6%
Medium-Hub	37	0.25% to 1% of passenger enplanements	19.3%
Small-Hub	72	0.05% to 0.25% of passenger enplanements	7.7%
All Hub Airports ➤	**140**	**More than 0.05% of passenger enplanements**	**96.6%**
Non-Hubs	282	Less than 0.05% of passenger enplanements	3.2%
All Primary Airports ➤	**422**	**More than 10,000 passenger enplanements**	**99.8%**
Other CS Airports	124	2,500 to 10,000 passenger enplanements	0.1%
All CS Airports ➤	**546**	**More than 2,500 passenger enplanements**	**99.9%**

Figure 2-1
Commercial Service (CS) Airports in the U.S.

The number of large-hub, medium-hub and small-hub airports can vary from year to year because the classification is based on a percentage of total passenger enplanements rather than a fixed number. For example, from 1998 to 1999 the number of large hubs increased from 30 to 31 because enplanements at Ft. Lauderdale grew more rapidly than did total passenger enplanements, moving it above the one percent threshold. In the same period, the number of medium hubs decreased from 42 to 37, the number of small hubs increased from 70 to 72.

Traffic in the United States is concentrated at the largest airports. Figure 2-1 also shows the percentage of total passenger enplanements for each airport type. The 31 large-hub airports accounted for 69.6 percent of total passenger enplanements in 1999, the 37 medium-hub airports for 19.3 percent, and the small hubs for another 7.7 percent (the140 hub airports had 96.6 percent of total passenger enplanements). The remaining 282 primary airports had only 3.2 percent of enplanements, while the 128 non-primary commercial service airports accounted for only 0.1 percent of enplanements.

2.1.2 General Aviation Airports

Airports that have less than 2,500 annual enplanements or do not receive any scheduled commercial service are considered general aviation airports. They are included in the NPIAS if they account for enough activity (generally defined as having at least ten based aircraft) and are at least 20 miles from the nearest NPIAS airport. Figure 2-2 shows the classes and numbers of general aviation airports and the percentage of total based aircraft at each.

Type of Airport	Number of Airports	Percentage of Based Aircraft
Relievers	315	33%
GA › 50 Based Aircraft	438	22%
GA › 25 Based Aircraft	584	11%
GA › 10 Based Aircraft	777	7%
GA ‹ 10 Based Aircraft	707	2%
All GA Airports ➤	**2,821**	**75%**

Figure 2-2
NPIAS General Aviation Airports in the U.S.

The 2,821 NPIAS general aviation airports are divided into reliever and general aviation airports. Relievers are high capacity general aviation airports in major metropolitan areas that provide general aviation pilots and aircraft with attractive alternatives to using congested commercial service airports. There were 315 relievers in 1999, including important airports such as Merrill Field in Anchorage, Alaska; Teterboro Airport in New Jersey near New York City; and Van Nuys in California. The remaining 2,506 general aviation airports generally serve rural areas, and have very little, if any, commercial service.

Although relievers and other general aviation airports have little commercial service, they do have a small number of passenger enplanements, primarily provided by air taxi operators. In 1999, 1,780 general aviation airports had some enplanements totaling only 0.1 percent of total passenger enplanements.

2.2 Airspace in the United States

Airspace in the United States is managed by the FAA to provide for its orderly and safe use. The NAS includes all airspace over the United States from 60,000 feet down to, but not including, the ground. Over the years, the FAA has promulgated numerous regulations that divide the airspace into different classifications and provide complex rules for operating within each classification.

2.2.1 Classes of Airspace

The national airspace is divided into two broad categories, controlled (Classes A through E airspace) and uncontrolled (Class G airspace). Within these two categories, there are a number of classifications that determine the flight rules, pilot qualifications, and aircraft capabilities required to operate within any section of the airspace. The specific classification of any area is broadly based on the complexity and density of aircraft movements, the nature of operations conducted within the airspace, the level of safety required, and the national and public interest. The six classes of U.S. airspace are described below and are depicted in Figure 2-3.

Class A Airspace

All airspace from 18,000 Mean Sea Level (MSL) to 60,000 MSL, including the airspace overlying the waters within 12 nautical miles of the coast of the contiguous 48 states and Alaska. All operations within Class A airspace must be under Instrument Flight Rules and are under the direct control of FAA controllers. Class A airspace always starts at 18,000 MSL and it is not specifically charted.

Class B Airspace

Airspace surrounding the nation's busiest commercial service airports. At its core it extends from the surface up to 10,000 MSL. Class B airspace is charted on sectional charts, IFR en route (low altitude) charts, and terminal area charts.

Class C Airspace

Airspace surrounding airports of mid-sized cities with a large number of commercial flight operations; it extends from 700 feet Above Ground Level (AGL) to 4,000 AGL. An operating control tower at the primary airport and radar services are key components of Class C airspace.

Class D Airspace

This airspace is applied to airports with operating control towers where the traffic volume does not meet Class C or Class B standards. This area encompasses 700 AGL to 2,500 AGL.

Class E Airspace

Includes all airspace from 14,500 MSL up to, but not including 18,000 feet MSL. Class E airspace also includes all other controlled airspace necessary for IFR operations at lower altitudes but not already classified as A, B, C, or D. This includes features such as low level airways (victor airways) and IFR transition areas.

Class G Airspace

Class G airspace is uncontrolled airspace and includes all airspace not otherwise designated as A, B, C, D, or E. Operations within Class G airspace are governed by the principle of "see and avoid."

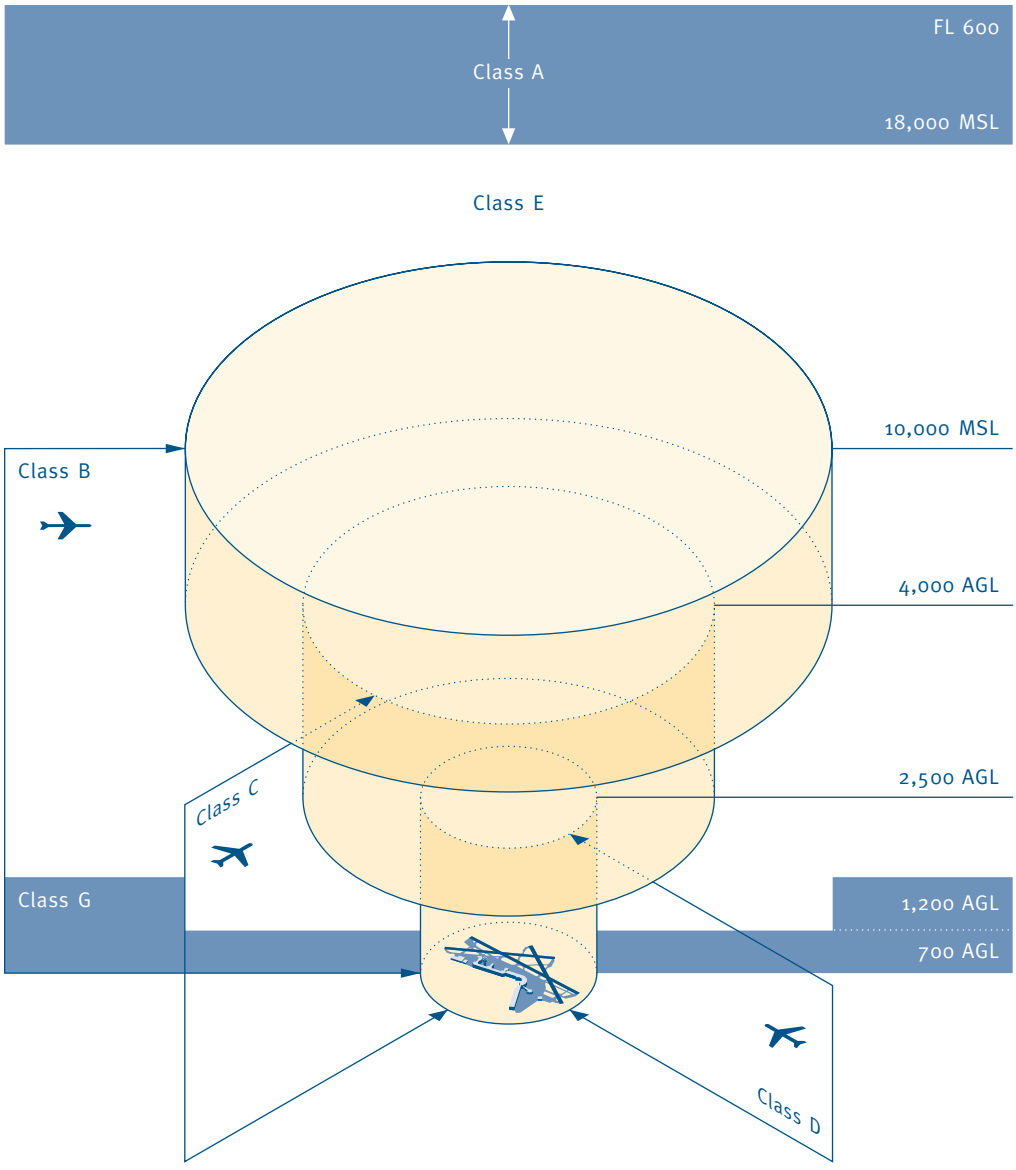


Figure 2-3
Classes of Airspace

En route airspace in the United States consists of several routing corridors used by both IFR and VFR traffic. Traffic is concentrated along these routes. Low altitude airways, termed victor airways, are the primary routes used by both IFR and VFR traffic. They are eight nautical miles wide and generally go from 1,200 feet above ground level up to, but not including, 18,000 MSL. The airway floor may be higher in areas of the western U.S. where terrain interferes more with the navigational facilities upon which the airways are based. They are depicted on aeronautical charts as blue shaded lines with a "V" (hence the term victor), followed by a number, such as V500, and are found on the sectionals, IFR en route low altitude charts, and terminal area charts.

Jet routes serve the same function as the low altitude airways except that they are found at 18,000 MSL and above (up to 45,000 MSL). Traffic on the jet routes is always IFR and is managed by air traffic control. Jet routes are shown on high altitude charts as a gray line and are designated by the letter "J," followed by a number, such as J547.

2.2.2 Special Use Airspace

Special use airspace (SUA) is designed to segregate flight activity related to military and national security needs from other airspace users. Although most SUAs involve military activity, others involve civilian users such as the Department of Energy or the U.S. Secret Service. Special Use Airspace is established by the FAA, usually at the request of the affected civilian agency or military branch. There are six different kinds of special use airspace: Prohibited Areas, Restricted Areas, Military Operations Areas, Alert Areas, Warning Areas, and Controlled Firing Areas.

Prohibited Areas

Prohibited areas are established over sensitive ground facilities such as the White House, presidential homes, and Camp David. All aircraft are prohibited from flight operations within a prohibited area unless specific prior approval is obtained from the FAA or the controlling agency.

Restricted Areas

Restricted areas are established in areas where ongoing or intermittent activities occur that create unusual hazards to aircraft, such as artillery firing, aerial firing, and missile testing. Restricted areas differ from prohibited areas in that most of them have specific hours of operation. Entry during those hours requires specific permission from the FAA or the controlling agency.

Military Operations Areas

Military Operations Areas (MOA) are established to contain certain military activities, such as air combat maneuvers, intercepts, and acrobatics. Civilian flights are allowed within an MOA even when the area is in use by the military. Air traffic control will provide separation services to IFR traffic.

Alert Areas

Alert Areas contain a high volume of pilot training or an unusual type of aerial activity, such as helicopter activity near oil rigs, which could present a hazard to other aircraft. There are no special requirements for operations within alert areas other than heightened vigilance.

Warning Areas
Warning areas contain the same kind of hazardous flight activity as restricted areas (artillery firing, aerial gunnery, etc.), but are located over domestic and international waters. Warning areas generally begin three miles offshore.

Controlled Firings Areas
Controlled firing areas contain civilian and military activities that could be hazardous to non-participating aircraft, such as rocket testing, ordinance disposal, and blasting. They are different from prohibited and restricted areas in that radar or a ground lookout is used to indicate when an aircraft is approaching the area, at which time all activities are suspended.

2.3 Air Traffic Control Facilities and Equipment

Air traffic control specialists ensure that air traffic moves safely and efficiently through the NAS. That traffic includes not only commercial flights, but also corporate, military, and general aviation flights.

Air traffic control is accomplished by three general classes of controllers, each resident in different types of facilities and responsible for a different phase of flight. First, ground and local controllers at Air Traffic Control Towers at airports handle aircraft from the gate to the taxiway and runway, through the takeoff, and at the other end of the flight, from landing back to the gate. Second, radar controllers at the Terminal Radar Approach Control facilities handle aircraft from takeoff to a cruising altitude at the origin (departure control) and return them through their approach at the destination (approach control). Third, en route controllers working at Air Route Traffic Control Centers manage the flow of traffic along the airways between the terminal areas. The overall flow of aircraft across the entire United States is managed by the Air Traffic Control System Command Center in Herndon, Virginia. In addition, flight service stations provide important pre-flight and in-flight services to general aviation pilots. The functions of each of these air traffic control facilities are described briefly below.

2.3.1 Air Traffic Control Towers

Air Traffic Control Towers (ATCT) at more than 400 airports control the effective movement of traffic both on the ground and in the air within approximately five nautical miles of the airport and up to an altitude of 3,000 feet. Air traffic controllers rely on a combination of technology and visual surveillance to direct aircraft departures and approaches, maintain safe distances between aircraft, and communicate weather-related information, clearances, and other instructions to pilots.

2.3.2 Terminal Radar Approach Control Facilities

Over 185 Terminal Radar Approach Control (TRACON) facilities sequence and separate aircraft as they approach and depart major metropolitan areas. TRACONs typically control air traffic within a 30-mile radius and less than 15,000 feet altitude, exclusive of ATCT airspace.

The traffic within terminal airspace consists mostly of takeoffs and landings to and from the airports in its area, but also includes air traffic that is overflying the area. Terminal airspace is divided into sectors that can be modified, based on the runway configurations in use by the airports within that TRACON's airspace.

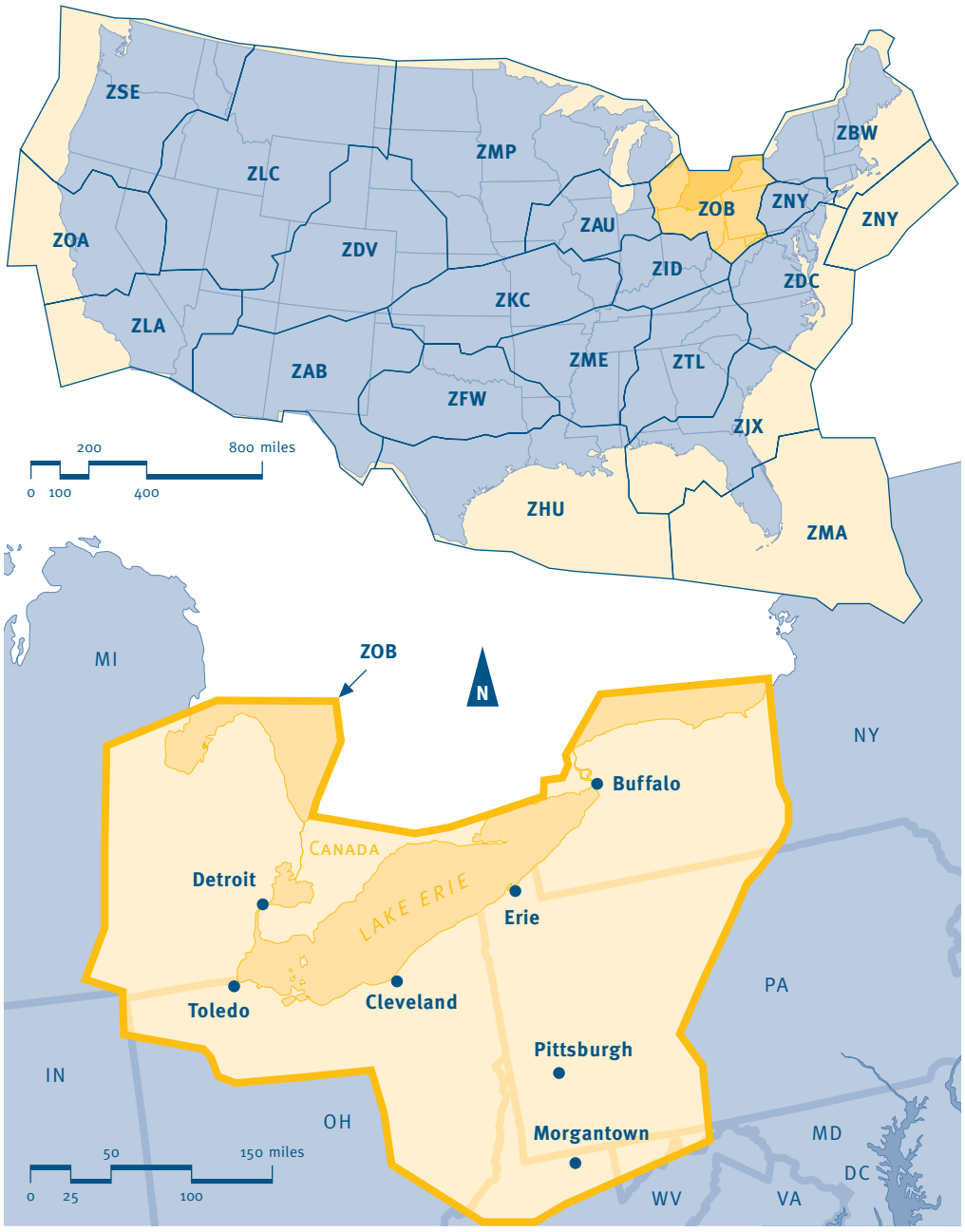
2.3.3 Air Route Traffic Control Centers

Twenty-one Air Route Traffic Control Centers (ARTCCs) control and monitor aircraft in transit over the United States and during approaches to some airports. Each en route center handles a different region of airspace, passing control from one to another as respective borders are reached until the aircraft reaches TRACON airspace or leaves U.S. airspace.

Three ARTCCs—Oakland, New York and Anchorage—also control aircraft over the ocean. Outside radar range, which extends only 175 to 225 miles offshore, controllers must rely on periodic radio communication of position reports to determine an aircraft's location.

Figure 2-4 shows the boundaries of the 20 continental ARTCCs and the airspace each controls (the Anchorage ARTCC is not shown.) The centers are designated by a three-letter code that begins with Z; for example, the Cleveland center is designated ZOB.

Figure 2-4
Airspace Managed by Centers



The size of the airspace managed by a center varies substantially, but typically consists of tens of thousands of square miles extending over several states. The Cleveland ARTCC, physically located in Oberlin, Ohio, just outside of Cleveland, controls approximately 70,000 square miles of airspace in six states and Canada. Figure 2-4 highlights the boundaries of the Cleveland ARTCC airspace.

An ARTCC's airspace is divided into sections of airspace called sectors. Sectors have vertical as well as horizontal boundaries. A few sectors extend from the ground up, but most are stratified, with the lowest sectors defined from the ground to 23,000 feet and another sector from 24,000 feet up (in some cases, a third sector may be defined for 37,000 feet and up). Figure 2-5 shows the boundaries of the Cleveland ARTCC's high altitude sectors.

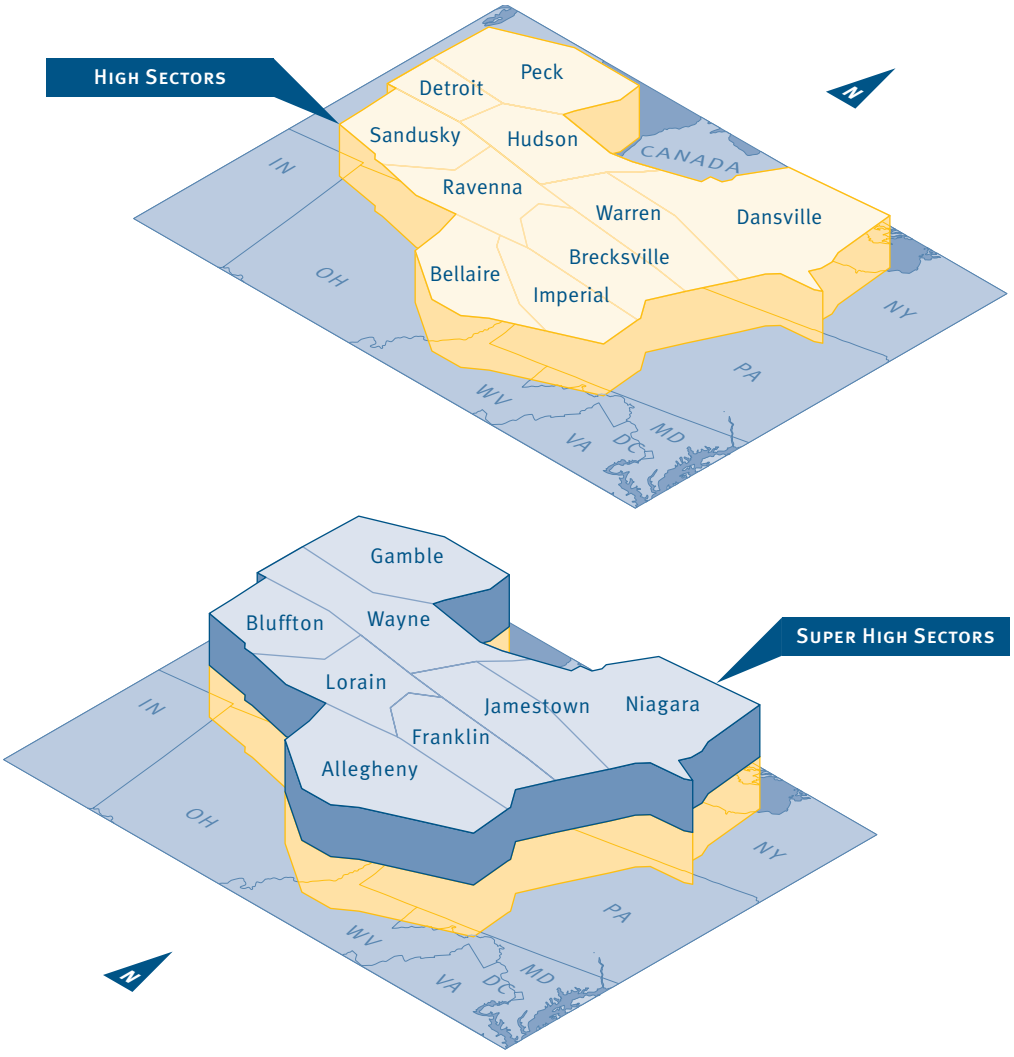


Figure 2-5
Boundaries of ZOB High Altitude Sectors

2.3.4 Air Traffic Control System Command Center

The Air Traffic Control System Command Center (ATCSCC) in Herndon, Virginia monitors traffic flows across the United States and communicates with other air traffic facilities and airline operating centers to minimize congestion and delays due to adverse weather, equipment outages, closed runways, and other capacity-related circumstances. The ATCSCC is one of the key parts of the FAA's evolving plan for management of an ever-increasing amount of air traffic. This role is highlighted in the Spring/Summer Plan.

2.3.5 Flight Service Stations

The air traffic control specialists at flight service stations provide pre-flight and in-flight services to pilots, primarily those in general aviation. The specific services provided include flight plan filing; preflight and en route weather briefings that include the status of navigational aids; airport condition reports; search and rescue operations; assistance to lost or disoriented aircraft pilots; provision of instrumental flight rule and special visual flight rule clearances, soliciting pilot reports on flying conditions, and providing special services such as customs and immigration. Pilots can receive these services by visiting a flight service station, by telephone, or through air-to-ground communications. The flight service stations also provide a weather briefing and flight plan processing service through the Direct User Access Terminal Service (DUATS), which can be accessed via toll-free telephone service.

2.4 Navigational Aids

An extensive network of facilities, generally known as navigational aids, or navaids, supports aircraft movement in the NAS. Pilots use en route navaids to guide aircraft from the vicinity of one airport to another. A typical en route navaid is the very high frequency omnidirectional range (VOR), which provides magnetic bearing information so that a pilot can determine the aircraft's position relative to the transmitter or its absolute position through triangulation with another en route navaid. There are approximately 1,026 VORs in the NAS.

Other navaids help a pilot descend from cruising altitude to land on an airport runway. The instrument landing system (ILS), which consists of a localizer for horizontal guidance and a glideslope for vertical guidance, provides instrument approach capability to the runway during low visibility. The localizer is placed beyond the stop end of the runway, aligned with the centerline. The glideslope is located beside the runway, near the touchdown point. An ILS may be certified as Category (CAT) I, II, or III, depending on its equipment configuration and system capabilities. There are currently 1,248 ILSs in the NAS. Of these, approximately 95 are approved for CAT II and/or III operations (because each runway needs a separate ILS to support instrument operations in low visibility, these 95 ILSs provide this capability at only 73 airports.) Lighting systems, such as the precision approach path indicator (PAPI) and runway end identification lights (REIL), are navaids that provide pilots with visual cues to assist them in making safe approaches and landings.

The FAA is transitioning from this system of ground-based navaids to a satellite-based system called the global positioning system (GPS). The basic GPS system is already being used by pilots for navigation in oceanic and en route airspace. Differential GPS will augment, and eventually replace, many of the ground-based navaids discussed above. The FAA anticipates that the GPS wide area augmentation system (WAAS) will provide en route, terminal, non-precision approach and selected CAT I precision approach capability throughout the NAS. The GPS local area augmentation system (LAAS) will provide CAT II and III precision approach and landing capability.